

## COCOON PARASITES OF THE ORIENTAL FRUIT MOTH\*

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There has accumulated in the past fifteen years a considerable body of literature which deals with parasites of the oriental fruit moth. In nearly all parts of the United States and Canada, where the moth has become established, are records of one or more species of insects which attack it. The number of parasites which have transferred to the fruit moth and the rapidity with which this has been accomplished is much more pronounced than in the case of certain other imported pests. Garman (3) reported an egg parasite (*Trichogramma*) and a larval parasite (*Macrocentrus*) of the fruit moth as early as 1917, one year after the first published note on the presence of the fruit moth in this country. This report was followed shortly by another report by Garman (4) and also by reports from Wood and Selkregg (9) and Stearns (7) which increased considerably the number of known species of fruit moth parasites. The spread of the fruit moth and the initiation of more and more studies dealing with its parasites added new species to the record from year to year. Stearns (8) and Haeussler (5) drew up lists of known fruit moth parasites. Haeussler's list, published in September, 1930, two years after that of Stearn's, contained 57 primary and 8 secondary parasites. These figures represent a gain of about 20 new species during the two year period. Since 1930 the writer has learned of a number of new species not recorded in Haeussler's paper. No doubt the number at present is much higher and will continue to increase.

A study of the literature of fruit moth parasites reveals the fact that the majority of the parasites recorded are those that attack the larvæ feeding in twigs and fruit. In a column

\* Paper of the Journal Series, New Jersey Agricultural Experiment Station, Department of Entomology.

headed "stage of host attacked," Haeussler (5, p. 366) lists the egg, larva, pupa, prepupa and cocoon as the stages in the life cycle of the fruit moth attacked by the different parasites. Thirty-nine of the fifty-seven primary parasites are listed as larval parasites. Stearns (8) lists nearly twice as many primary larval parasites as all other primary parasites combined. Practically all of the parasites so listed attack the larva during the feeding stage and before it spins its cocoon.

A study of the data in the papers cited and other papers would lead one to believe that the largest number of parasite species, and the most important ones, attack larvæ at the time they are feeding in the twigs and fruit or while they are transferring from one feeding point to another. This may or may not be true. There may be as many or more species attacking the cocoon stages of the fruit moth as there are attacking the precocoon stages, and they may be as important. Up to the present time, most of the work on fruit moth parasites has dealt with stages of the moth other than those within the cocoon. This was the logical point to begin a study of fruit moth parasites. The precocoon stages of the fruit moth are present in the orchard from spring until fall; they are readily located, are easily collected in large numbers, and can be reared to maturity, or until the parasites emerge, with a minimum of effort. On the other hand, the cocoon stages—particularly those of the summer—are relatively less easily located and require more careful handling to prevent injury to the host or the parasite. While up to the present, emphasis has been placed on the study of parasites of the precocoon stages of the fruit moth, the writer feels that more study of the parasites of the cocoon stages is needed. One or more stages of the fruit moth in the cocoon are present in the orchard practically the whole year. Furthermore, the fruit moth, from the time the larva leaves its feeding place until the cocoon is spun and on through the larval, prepupal and pupal stages within the cocoon, is particularly susceptible to attack by parasites. A thorough study of the cocoon parasites in different parts of the country may bring forward a species more favorable for mass production and liberation than *Macrocentrus* or *Trichogramma*.

The interest of the writer in cocoon parasites was aroused soon after he was assigned to the fruit moth problem in 1927. In the spring and summer of 1927, and the two previous years, weekly collections of twig feeding larvæ were made in several localities in northern New Jersey and several in southern New Jersey. It was observed (2, p. 4) that, in general, the first brood twig larvæ in southern New Jersey localities were parasitized heavily whereas the larvæ of the first brood in northern New Jersey were parasitized lightly. The build up of the moth in succeeding generations in northern New Jersey was not as pronounced as one would expect from the low parasitism of twig feeding larvæ of the first brood. This led to the thought that other stages and particularly the cocoon stages might be heavily parasitized. Collections of fruit moth hibernacula were begun in the late winter and spring of 1928 for the purpose of determining the percentage of parasitism and the kind of parasites. Some of the parasites obtained from this material and from fruit moth pupæ exposed in the orchard in 1928 were recorded in a paper (1) printed in the journal of this society in 1930. These studies were continued in the summer of 1928, in 1929, and 1930. This paper sets forth some of the data obtained.

#### PARASITISM OF COCOONS COLLECTED IN THE SPRING OF 1928

Collections of fruit moth hibernacula were made from the rough bark of peach tree trunks and large limbs at the three northern localities, New Brunswick, South River and Glen Moore and from the southern New Jersey locality of Riverton. An effort was made to collect the hibernacula with as little disturbance to the contents as possible. In about half of the material collected the cocoons were mutilated to a point where the larva, pupa or parasite was exposed. The specimens thus collected were placed each in individual vials, suitably recorded and stored in an open insectary to await emergence. Collections were made at New Brunswick, April 20, 26, 29 and May 4; at South River, March 26, April 12 and 30; at Glen Moore, April 7 and May 3; and at Riverton, on March 27 and April 30. Table 1 shows the total number of individuals collected and the percentage parasitized.

TABLE 1

PERCENTAGE OF PARASITES AND MOTHS OBTAINED FROM ORIENTAL FRUIT MOTH HIBERNACULA COLLECTED IN MARCH, APRIL AND MAY, 1928, AT FOUR LOCALITIES IN NEW JERSEY

Locality	Hibernacula collected	Fruit Moths, per cent.	Parasites, per cent.
New Brunswick .....	96	12.5	87.5
South River .....	88	26.2	73.8
Glen Moore .....	60	21.7	78.3
Riverton .....	27	74.1	25.9

The data in table 1 may appear as a rather small number of hibernacula collected. It should be borne in mind, however, that the collections were made in the spring after the natural winter mortality had taken place. The winter mortality, due to diseases and other causes, may be rather high (5, p. 377, and 6, p. 26). The practice of treating the trees with paradichlorobenzene in the fall is another factor which would tend to cut down the number of larvæ to be found on the tree the following spring.

The data in table 1 show a rather high percentage of parasites present in the collections at the three northern New Jersey localities, New Brunswick, South River and Glen Moore. At New Brunswick and South River approximately half of all the parasites were a species of *Eurytoma*.<sup>1</sup> *Calliephialtes* n. sp. was also fairly abundant at these localities, and was followed in much smaller numbers by *Aenoplex betulaecola*, *Eupelmus* sp. and *Pristomerus ocellatus*. At Glen Moore the parasites were about equally divided between the three species, *Eurytoma* sp., *Calliephialtes* n. sp. and *Eupelmus* sp. At Riverton *Calliephialtes* n. sp. was the most numerous parasite.

No specimen of *Glypta* or *Macrocentrus* was reared from any of the collections. *Pristomerus ocellatus* was known to be a parasite which attacks a precocoon stage of the fruit moth. *Calliephialtes* and *Aenoplex* appeared to be a primary parasite which attack the cocoon stage. *Eurytoma* and *Eupelmus*, on the other hand, appeared to be hyperparasites attacking *Glypta*

<sup>1</sup> The parasites were identified by specialists at the National Museum in Washington, D. C.

*rufiscutellaris*. The fact that these two hyperparasites were present in large numbers in the spring of 1928 and was followed by a marked decrease in the percentage of *Glypta* in the summer of 1928, has been noted (2, p. 16).

#### PARASITISM OF COCOONS COLLECTED SPRING OF 1929

The collections of hibernacula were continued in March and April, 1929, in the same orchards where the collections were made in 1928. The procedure used in collecting and handling the material was the same as was employed in 1928. Table 2 shows the percentage parasitism found in the spring of 1929.

TABLE 2

PERCENTAGES OF PARASITES AND MOTHS OBTAINED FROM ORIENTAL FRUIT MOTH HIBERNACULA COLLECTED IN THE SPRING OF 1929 AT FOUR LOCALITIES IN NEW JERSEY

Locality	Hibernacula collected	Fruit Moths, per cent.	Parasites, per cent.
New Brunswick .....	116	50.0	50.0
South River .....	52	84.6	15.4
Glen Moore .....	32	87.5	12.5
Riverton .....	36	58.3	41.7

The data in table 2 show a decided drop in cocoon parasitism in the spring of 1929 as compared to the parasitism in the spring of 1928 in the three northern New Jersey localities. At Riverton the parasitism increased in 1929 over 1928. In general the same group of parasites were present in 1929 as were present in 1928. *Aenoplex* and *Calliephialtes* were again present as were the two hyperparasites, *Eurytoma* and *Eupelmus*. The parasite *Dibrachys boucheanus* appeared in larger numbers than the previous year. For the second year no specimen of *Glypts* or *Macrocentrus* was reared from the spring collected hibernacula.

The peach crop in New Jersey was more heavily infested in 1929 than any year since 1924. In orchards of the Belle of Georgia, Elberta and Fox Seedling varieties at Glen Moore, New Brunswick, South River, Dayton, and Manasquan, fruit infestations ranged from 30 to 80 per cent. The data in tables 1 and

2, while not extensive enough to warrant the drawing of a definite conclusion, point to a possible relationship between the parasitism of the cocoon stages and the subsequent build up in fruit infestation.

RELATIVE PARASITISM OF OVERWINTERING LARVÆ COLLECTED  
IN THE FALL AND SPRING

The majority of the parasites obtained from the spring collections of 1928 and 1929 probably represented species that attack some stage within the cocoon and were not species that normally attack the feeding larvæ. This probability is strengthened by the fact that most of the species had never been reared from larvæ collected at the time they were feeding. Furthermore it has been shown (5) that the parasitism of larvæ cut from late ripening peaches is quite low. In order to throw further light on the question of where the parasitism found in the hibernacula in the spring took place, the writer carried out the following experiments from 1928 to 1930. Burlap bands were placed around Elberta and Krummel trees at New Brunswick in the late summer of 1928 and again in the late summer of 1929. The hibernating larvæ were removed twice a week from one-half of the bands, placed in vials with pieces of straw paper corrugations and the vials stored in the insectary to await emergence. The remaining half of the bands were left undisturbed until the following spring. They were then removed and the hibernacula, which the larvæ had constructed in and under them, collected and placed in vials for emergence records. The data from these experiments are set forth in table 3.

TABLE 3  
COMPARATIVE PARASITISM OF OVERWINTERING LARVÆ COLLECTED IN THE  
FALL AND SPRING AT NEW BRUNSWICK FROM BANDS PLACED  
ON ELBERTA AND KRUMMEL TREES

When collected	Total no. collected	Fruit Moth, per cent.	Parasites, per cent.
Fall, 1928 .....	79	96.1	3.9
Spring, 1929 .....	74	56.8	43.2
Fall, 1929 .....	462	94.3	5.7
Spring, 1930 .....	282	65.6	34.4

The data in table 3 show that those larvæ that go over the winter on the tree are much more heavily parasitized than the larvæ collected shortly after they leave the fruit and begin constructing their winter cocoons. Since the spring and fall collected material came from the same source, the difference must be due to parasites which attack the cocoon stages. The small parasitism of the larvæ collected in the fall was made up principally of the two species of *Macrocentrus*—parasites which are known to attack the feeding larvæ.

The parasites obtained from the bands in the spring, collections were in general the same as those found in the spring collections of 1928 and 1929. *Aenoplex* was the most numerous, followed by the several species of hyperparasites previously mentioned. There was a scattering number of *Calliephialtes* and an occasional specimen of those species which attack feeding larvæ.

While collecting larvæ from under the bands in the fall of 1929, the writer found a number of larvæ in recently spun cocoons which at first examination appeared to be diseased. They were limp and flaccid, and showed no response to stimulation. Further examination of additional specimens showed that each larva had attached to it a tiny parasitic larva. A number of these paralyzed fruit moth larvæ were collected and an effort made to rear the parasites to maturity. Only one adult parasite was obtained. This proved to be a species of *Aenoplex*.

#### SUMMARY

A large number of species of insects have been recorded as parasites of the oriental fruit moth. To date most of the work has dealt with those species which attack the egg and feeding larva. In comparison, the species attacking the cocoon stages have been given little attention. Studies carried on in New Jersey from 1928 to 1930 show (1) that a high percentage of parasitism may be found in overwintering hibernacula collected in the spring, (2) that for the most part the species encountered are not the same as those found attacking the egg or feeding larval stages, and (3) that the majority of this parasitism takes place after the cocoon is formed or during the process of cocoon formation.

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